11/10/00 Shinskey Expert Report

Report Concerning Whether Hamilton Sundstrand's APS 3200 Auxiliary Power Unit Infringes U.S. Patent Nos. 4,380,893 and 4,428,194

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Qualifications:

My degree is a Bachelor of Science in Chemical Engineering, received from the University of Notre Dame in 1952. Upon graduation, I was commissioned a Naval officer, serving the next two years in the Korean theater as Ass't Gunnery Officer and Electronics Repair Officer on a radar-picket destroyer. In 1954, I joined duPont as a Process Engineer at the Savannah River Plant. In 1955, I joined Olin Chemical Corp. at Niagara Falls as a Process Engineer, becoming an Instrument Engineer in 1957. In 1960, I joined The Foxboro Company, Foxboro MA, as a Systems Engineer, later becoming Chief Application Engineer, Process Control Consultant, and Bristol Fellow. I retired from The Foxboro Company in 1993, becoming an independent Process Control Consultant, a position which I now hold.

I have written 11 books and 136 papers on process control, and hold 17 patents on process control methods and apparatus. I have received three awards on process control work from the Instrument Society of America, plus a fellowship, and one award each from the American Institute of Chemical Engineers, the Institute of Measurement and Control (U.K.), the Nordic Process Control Group, and the American Automatic Control Council.

In addition to designing instrumentation and control products, I have experience in applying and commissioning control systems in the following industries: chemical and plastics, petroleum production and refining, pulp and paper, mining and metals, pharmaceutical, power (fossil, nuclear, and geothermal), food and beverage, aircraft, water and wastewater.

using Eq. (1), and the result, termed the "flow-related parameter" is sent as the controlled-variable input to the surge controller, which controls it at set point by manipulating the surge bleed valve. From Fig. 1 it can be seen that the volumetric flow at which surge occurs is a function of IGV position; therefore the set point for the surge controller in the patents is set as a function of IGV position, as shown in Figs. 4 and 6 of the patents.

The control system for the APS 3200, as described in APS 3200 ECB Requirements Specification, Rev. N of August 23, 1996, has no flowmeter: no pitot tube, orifice, venturi, or other device specifically intended for producing a velocity head such as used in the above-referenced patents. The differential pressure is instead measured across the diffuser, a set of stationary vanes which accept the high-velocity stream leaving the impeller tip and convert some of the velocity into a pressure rise, as opposed to the pressure loss measured across a flowmeter. Typically, about half of the pressure rise in a centrifugal compressor is developed across the impeller and half across the diffuser (Perry, p. 10-47). Therefore, diffuser pressure-rise is an indication of the compression ratio achieved by the compressor, as well as the flow through it. In the author's experience, diffuser $\Delta p/p$ constitutes a unique measure of potential surge conditions within a centrifugal compressor, a measure not described elsewhere in patents or prior art.

In addition to the diffuser Δp representing a pressure rise as contrasted to a pressure loss measured across a flowmeter, the magnitude of the Δp is also striking. Its measured range is specified as 0-25 psi (APS 3000 System Requirements Specification, p.15). By comparison, the differential pressure measured across a pitot tube in the discharge duct of a compressor typically is of the order of 5 inches of water column, and across an orifice plate, 20